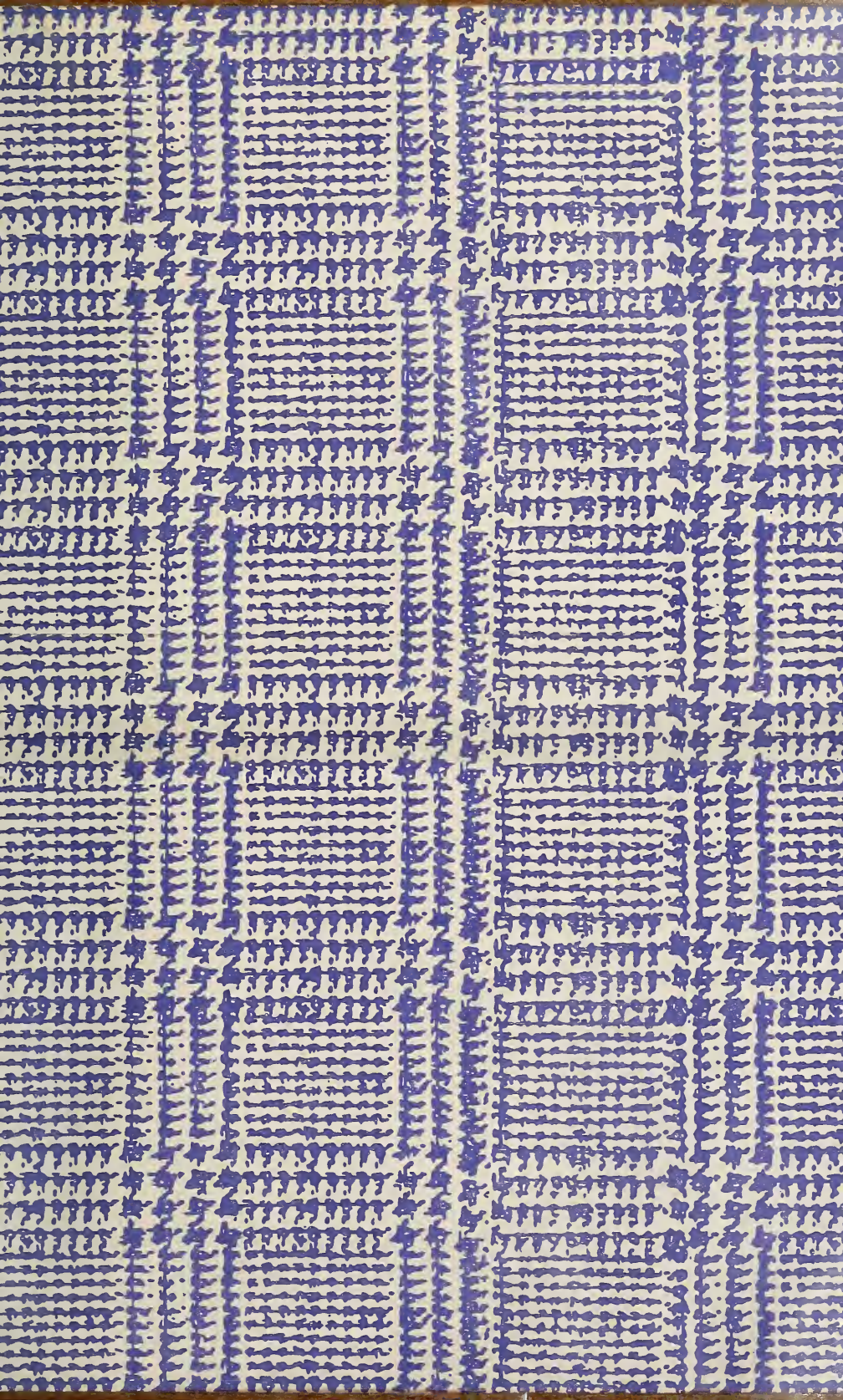

Glaucoma: A Disease of the Eyes Dangerous to Eyesight

By

The Professor of Ophthalmology, Medical School of Harvard University, Cambridge, Mass.

National Society for the Prevention of Blindness
370 Seventh Avenue, New York, N. Y.

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Glaucoma: A Disease of the Eyes Dangerous to the Eyesight

The disease known as glaucoma causes probably one-third of all blindness occurring in the latter half of life. A very large part of this loss of sight is preventable and it is the purpose of this article to give the salient facts of this disease, about which at the present time dense ignorance exists.

In the first place, it is necessary to learn a few facts about the anatomy and physiology of the normal eyeball. This can be accomplished best by means of diagrams: Figure 1 is a section of the human eyeball cut lengthwise. The letter "A" is the clear watchglass front (cornea) of the eyeball through which we look; "B" is the anterior chamber, a space filled with clear fluid, known as the aqueous; "C" is the iris, a movable diaphragm, the opening of which is indicated as "D", the pupil. Back of the iris and the pupil lies "E", the lens which focuses the rays of light. The interior of the eye, "F", is known as the vitreous chamber, and is filled with a clear, jelly-like fluid. The little frill-like processes, "G", which surround the lens, are to be noted; these are the ciliary processes. They are very important and will be referred to again later. In the back of the eye is "H", the great optic nerve whose fibers spread over the interior of the eye and form the retina.

If you will place your fingers on your own eyeball, you will find that it is firmly elastic to the touch. In other words, to maintain its shape and fulfil its functions the fluids within the eye must be maintained at a certain degree of tension or pressure. Now this concerns us deeply, since glaucoma represents an increase of the pressure within the eye. Let us see the mechanism by which this pressure is maintained. Let us draw a line vertically through Figure 1 and take the front half

and magnify it into Figure 2. We now see more clearly "G", the little frills which are known as the ciliary processes. From these processes is thrown constantly the watery fluid known as the aqueous, which maintains the pressure in the eye and nourishes some of the structures, like the lens, which have no

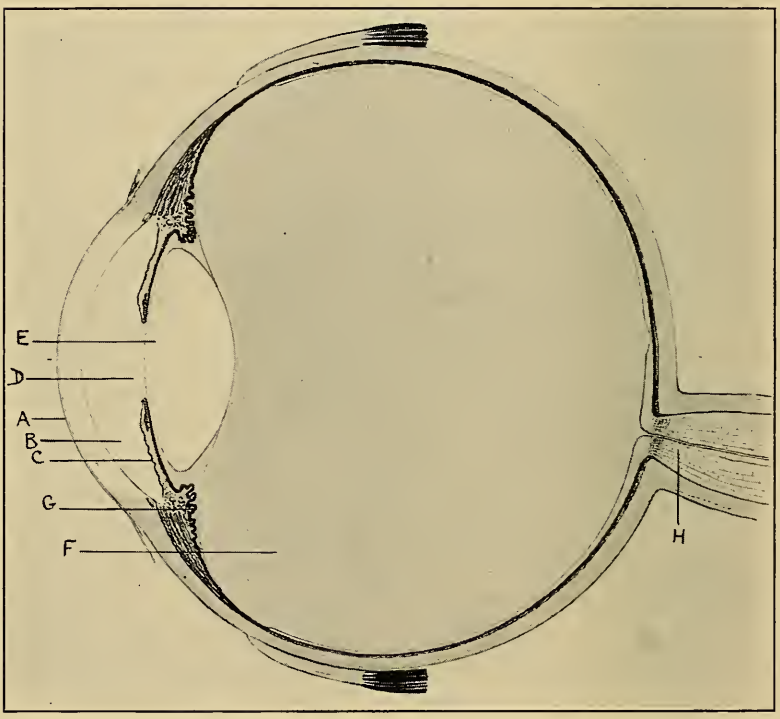

Fig. 1.—Cross-section of the human eye. A, cornea; B, anterior chamber; C, iris; D, pupil; E, lens; F, vitreous chamber; G, ciliary processes; H, optic nerve.

blood-vessels. A small amount of this fluid passes back into "F", the vitreous, but most of it passes forward through the pupil into "B", the anterior chamber. Here it must find some way of escaping from the eyeball or it would accumulate there and the eyeball would become hard. To accomplish this purpose there is a very delicate little sieve situated at the angle of

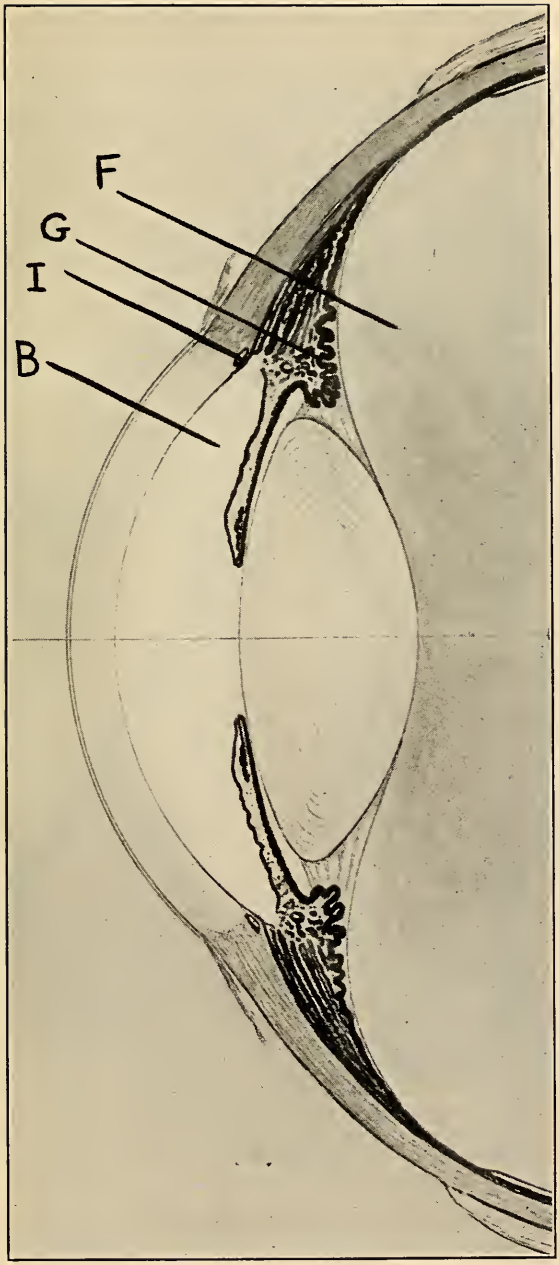

Fig. 2.—Enlarged front of an eye as seen in Fig. 1, showing the ciliary processes more clearly. F, Vitreous; B, anterior chamber; G, ciliary processes; I, pectinate ligament.

the anterior chamber and known as the pectinate ligament,

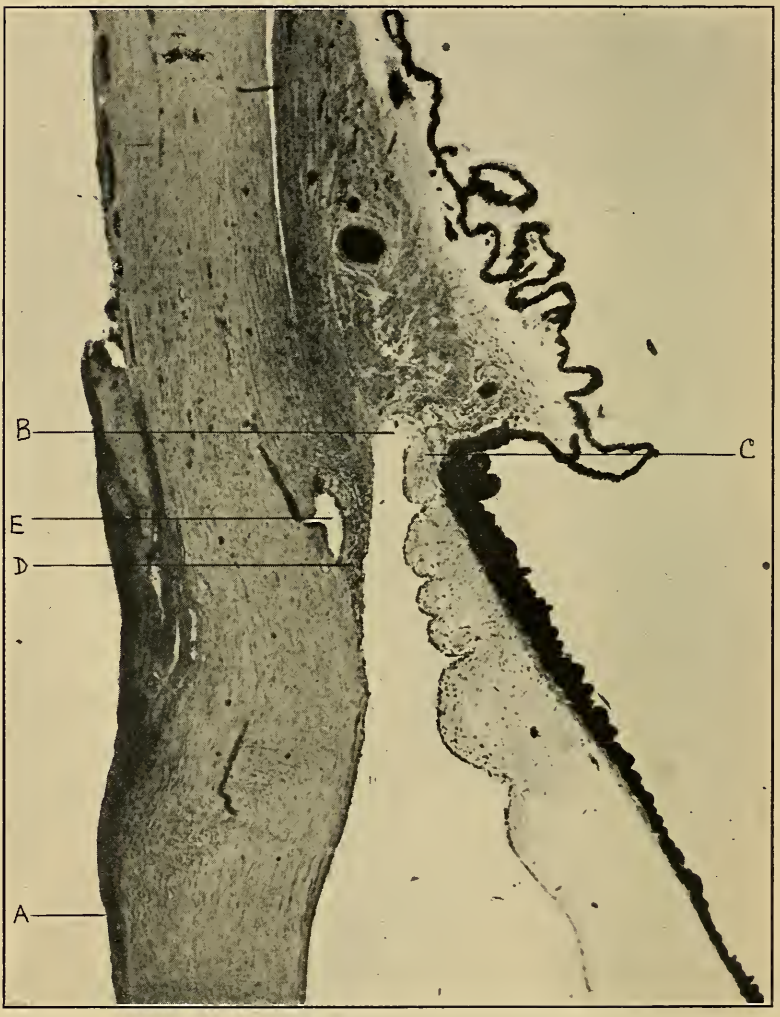

Fig. 3.—The angle of the anterior chamber, showing important points in the development of glaucoma. A, margin of cornea; B, angle of the anterior chamber; C, root of the iris; D, pectinate ligament; E, channel which conveys fluid outside the eye.

indicated by the letter "I". Let us take an enlargement of this region and call it Figure 3. "A" is the margin of the

cornea, "B" is the angle of the anterior chamber, "C" is the root of the iris, and "D" is the sieve known as the pectinate ligament. This little sieve or filter allows the fluid to escape from the eye into the meshes of the sieve and from there into a system of veins which convey it outside the eyeball. "E" is a large channel whose function it is to convey the fluid outside the eye. Now let us suppose that these outlets from the eye become stopped up. Then the pressure within the eye will rise and a serious condition will develop, because the delicate structures within the eye, the delicate nerve-fibers which spread out from the optic nerve and form the retina, become compressed. When this condition of increased pressure of the eyeball occurs, it is known as glaucoma. We do not know the causes of most forms of glaucoma, but we know what happens.

Figure 4 shows the front of the eye. The dotted circle, "I", represents the sieve-like pectinate ligament through which the aqueous fluid drains. Now one of two things can happen: The whole of the circle can become suddenly stopped up by pressure from behind. This will cause a sudden rise in the pressure within the eye, the eye becomes rather hard, it is red, the pain is intense, the front of the eye becomes grey and cloudy, the sight becomes dim, and finally, unless the pressure is relieved, sight is permanently lost. This is known as acute glaucoma. We shall not devote any more time to it than to say that the pain is so acute and the loss of sight so alarming that the individual almost always seeks medical advice and sight can usually be restored by a skilful operation if performed within the first day or two. This form of glaucoma furnishes its own unmistakable danger signals.

The form of glaucoma which we wish to bring to your notice is one without early danger signals, a form which causes an infinitely greater amount of loss of sight and blindness than does the acute form. Let us suppose that the drainage apparatus which we have described becomes gradually obstructed and that the pressure within the eye gradually becomes higher. The delicate fibers of the optic nerve gradually lose their function and die.

(Compare Figure 5 with Figure 3.) Here the pectinate ligament has become partially blocked, some fluid can still get through, the root of the iris has been pushed forward and has now adhered to the back of the cornea. This change is practically always found in cases of chronic simple glaucoma, which is the type of disease which is so important for us to understand.

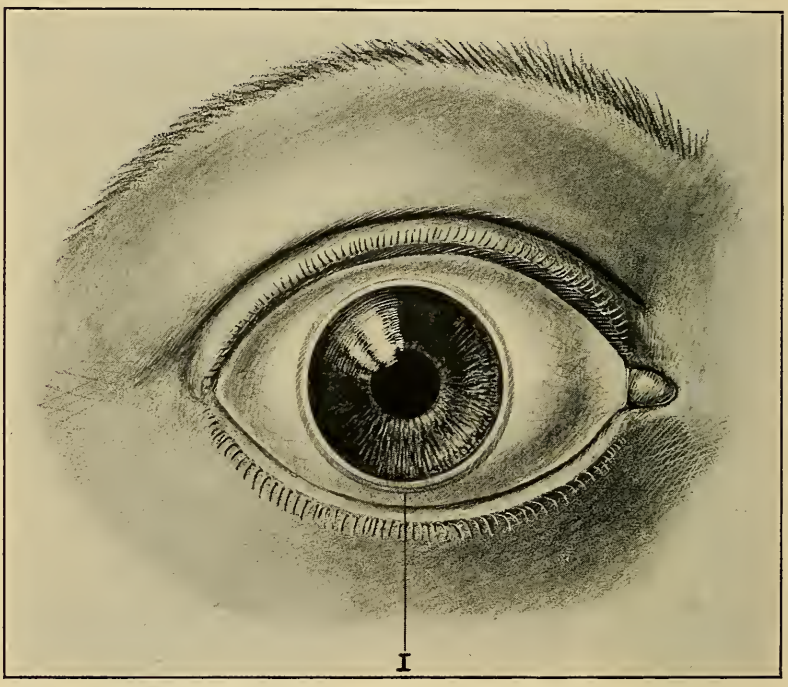

Fig. 4.—Front view of the human eye. Large black center is the pupil; surrounding dark area, iris, and outer dotted circle I, is a diagrammatic representation of the tiny channel through which fluid is removed from the eye. In Fig. 3 it is designated as E.

Let us now go to the back of the eye and see what changes increased pressure produces there. Figure 6 represents the posterior half of the eye. We see the optic nerve, "A", spreading its fibers over the interior coat of the eye, "B", the retina, the seeing membrane of the eye. The pictures of all objects which we see are thrown on this membrane from the outside

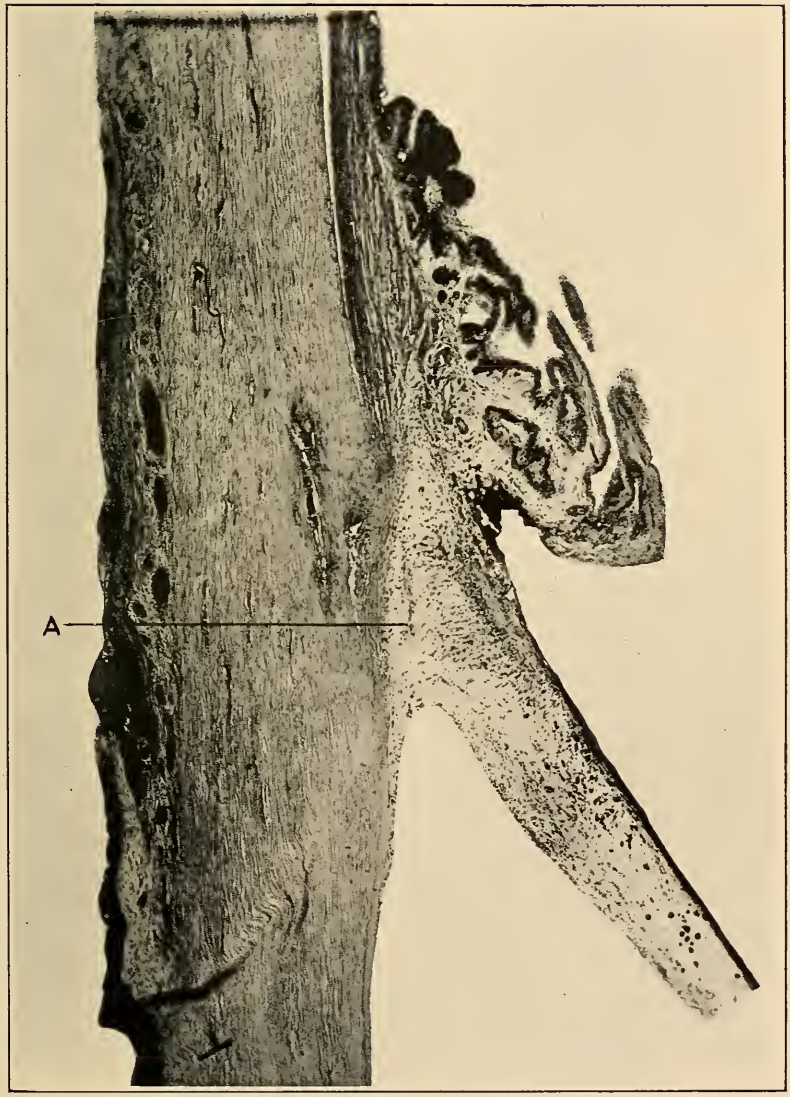

Fig. 5.—An enlarged reproduction of the angle of the anterior chamber, showing partial blocking of the pectinate ligament. A, Point at which root of the iris is adherent to the back of the cornea.

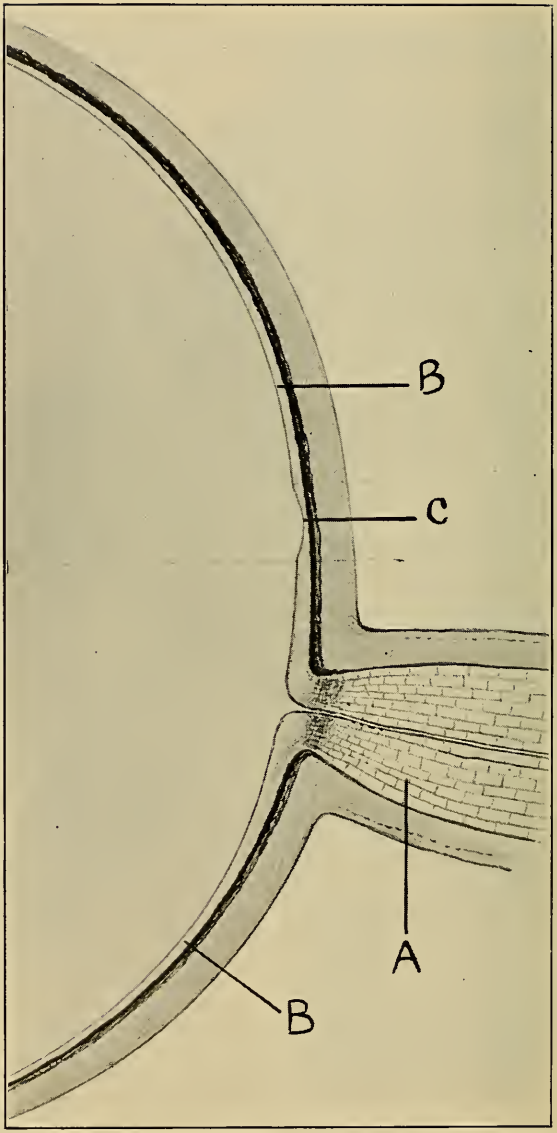

Fig. 6.—Cross-section of the posterior part of the eye, showing, A, optic nerve; B, B, retina; C, area of the macula or place of acute central vision.

world. If these pictures are to be seen distinctly, they must fall on one small area, the macula lutea, or yellow spot, which is situated directly in the center of the back of the eye. The yellow spot, "C", forms a small depression in the retina. The entrance of the optic nerve has no retina over it; therefore it is blind and it is known as the blind spot. Every one has this blind spot. If you will close your left eye and hold Figure 7 about 10 inches away and look at the circle the cross will not be seen—its image falls on the blind spot. If you will hold the tip of your finger a few inches away directly in front of your right eye with your left one closed and look directly at your finger-tip, you will find that your clear vision for objects beyond is lost and that the objects that you see around your finger-tip are seen indistinctly; only objects seen with central vision

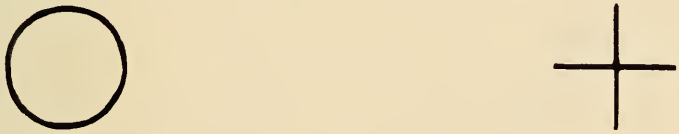

Fig. 7.—Chart used to locate the blind spot. By closing left eye and looking at the circle at a distance of from 8 to 10 inches, the cross is invisible, since its image strikes the blind spot of the eye, i. e., where the optic nerve enters the eye.

are seen distinctly—everything else is blurred. In the development of the human species central vision is a late acquisition. The lower animals do not have it. The rabbit cannot see anything very distinctly, but he makes up for it by being able to see almost around the whole circle, as his eyes are placed in the side of his head. Thus his very wide field of vision is a great protection against danger. In the human species the eyes are placed in the front of the head and the field of vision of each eye is limited by the conformation of the face. To the outer side one can see at right angles (90°); at the nasal side the limit is about 60°; below, 70° to 80°; above, 45° to 55°. These facts about central vision and the field of vision must be known if we are to appreciate the changes which take place in chronic simple glaucoma. Figure 8 represents the normal field of vision

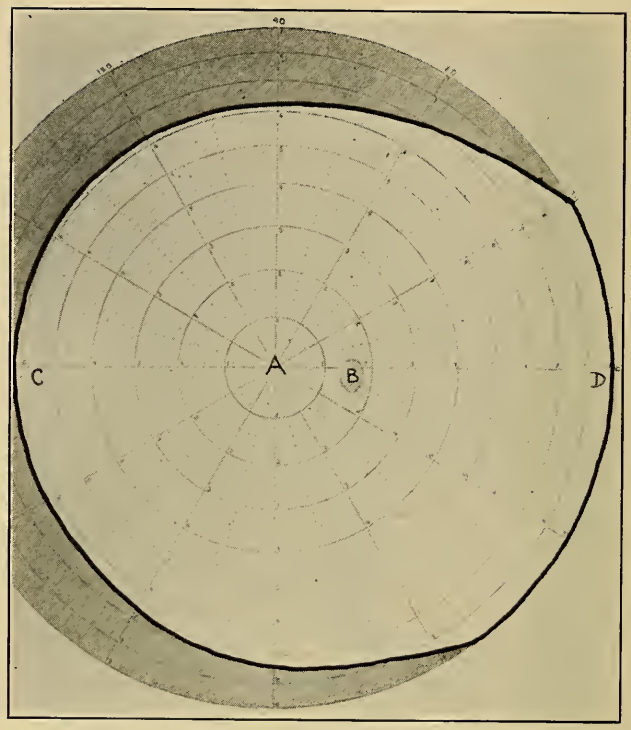

Fig. 8.—Diagrammatic charting of the field of vision of a normal eye. A, center area of acute vision; B, blind spot; C, nasal side; D, temporal side.

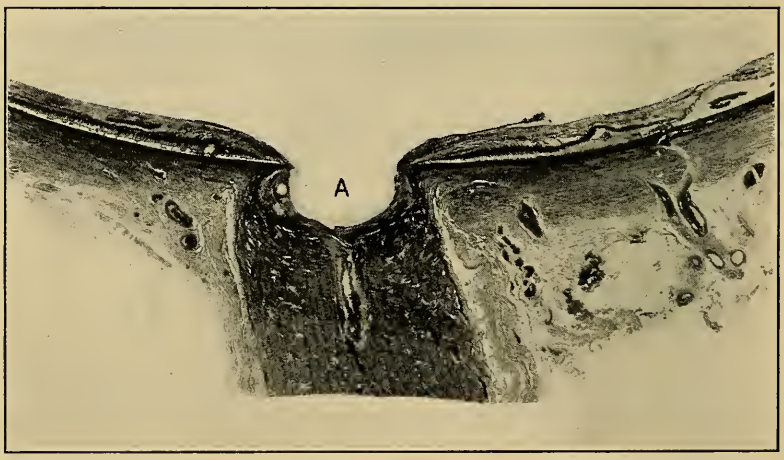

Fig. 9.—Cupping of the optic nerve due to the high inside pressure in a glaucomatous eye. A, is known as a glaucomatous cup. Compare with Fig. 6.

of the right eye as you face it. "A" is the central area of acute vision; "B" is the blind spot; "C" is the nasal side constricted by the nose; "D" is the outer or temporal side. (Compare Figure 9 with Figure 5.) In Figure 5 we see the normal optic nerve entrance, in Figure 9 we see the nerve entrance in glaucoma. How the nerve-fibers have been pressed in is evident. This concavity, "A", is known as a glaucomatous cup. Looking into the eye with an instrument known as an ophthalmoscope one sees Figure 10, the normal optic nerve head. Figure 11 represents a nerve head showing a glaucomatous

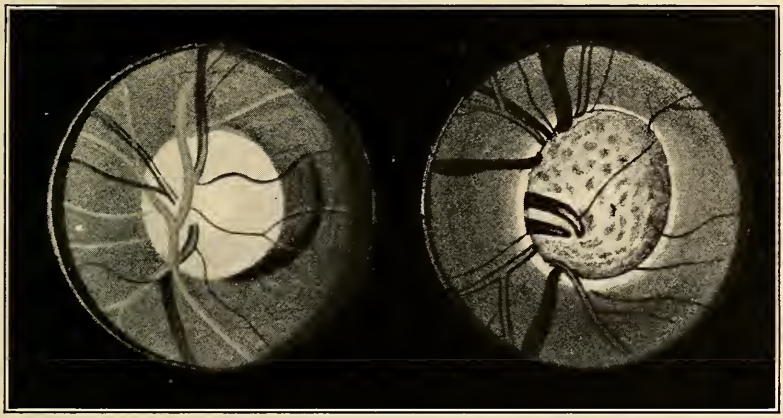

Fig. 10 Fig. 11

Figs. 10 and 11 illustrate respectively what a doctor sees in a normal eye and a glaucomatous eye through an ophthalmoscope: 10 is a normal optic nerve head; 11 is a glaucomatous one.

cup. This cup is caused by the increased pressure in the eye. This increase in pressure can be accurately measured by an instrument known as a tonometer. A drop of holocain to render the eye insensitive is applied, the base of the tonometer is placed on the front of the eye, and a reading is taken. Figure 12 represents the tonometer of Schiötz. Figure 13 indicates the base of the tonometer indenting the front of the eye. Thus we have now two signs by which chronic simple glaucoma can be recognized by the expert physician who has specialized in

diseases of the eye. He can look into the eye and see the glaucomatous cup, and he can determine the increased pressure with the tonometer. Now the increased pressure damages the fibers of the optic nerve which form the retina and this damage shows itself in a peculiar way. It affects the yellow spot and central vision late in the disease. Thus, up to a late stage in chronic simple glaucoma we can see directly in front of us just

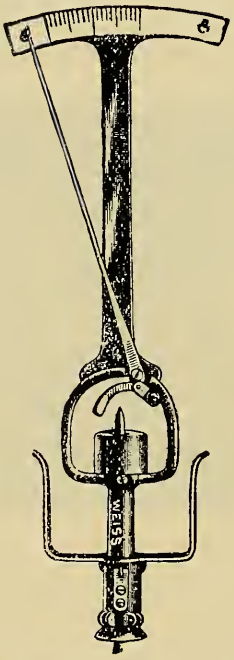

Fig. 12.—Tonometer used to measure the pressure in the eye.

as well as we ever could. This is one reason why so much loss of sight is caused by this disease, because as long as a person can see distinctly in front of him he does not become alarmed. When central sight becomes indistinct the disease is in a late stage and much more difficult to contend with. The field of vision, however, becomes affected relatively early in this disease and if we know the characteristic changes which occur

and can find them by making a chart of the field of vision, we are in an immediate position to help the patient. There are two characteristic early changes in the visual field. One is a characteristic notching, like a piece of pie, on the nasal side, known as the nasal step. The second is an enlargement of the blind spot known as Bjerrum's sign.

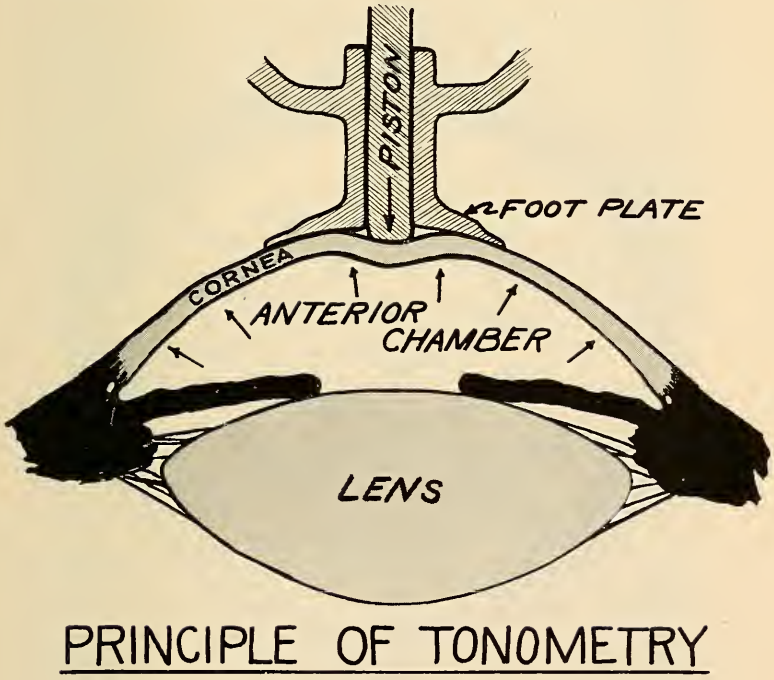

Fig. 13.—Indicates the base of the tonometer indenting the front of the eye.

Compare Figure 14 with Figure 8, showing the normal field of the left eye. In Figure 14 we see the nasal step, "A", and the enlarged blind spot, "B". Compare Figure 8, the normal field of vision, with Figures 14, 15, 16, 17, and 18, showing various types of progressing glaucomatous fields. The white areas represent the part of the field which still sees, the black areas are blind.

We now have the three cardinal signs of chronic simple glaucoma which can be recognized by the expert: The increase of pressure, as measured by the tonometer, the cupping of the nerve head, as seen with the ophthalmoscope, the contraction of the field of vision, best measured by an instrument known as

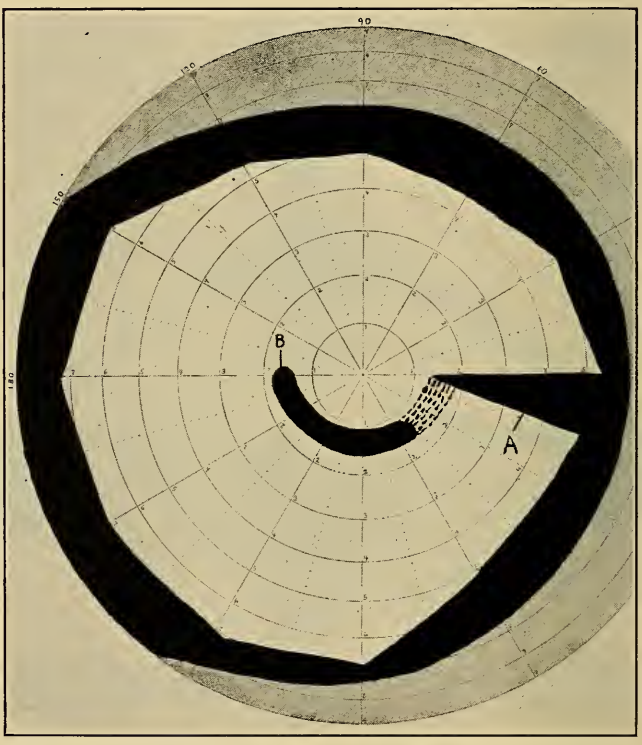

Fig. 14.—Diagrammatic charting of the field of vision, showing slight progress of glaucoma. The white area still sees; the encroaching black areas are blind. Compare with Fig. 8.

the perimeter. The field of vision can, however, be measured roughly by closing one eye, looking straight forward with the other, and moving the hand (especially on the nasal side) in from the periphery. In this way a rough idea of the visual field contraction can be determined. In advanced glaucoma

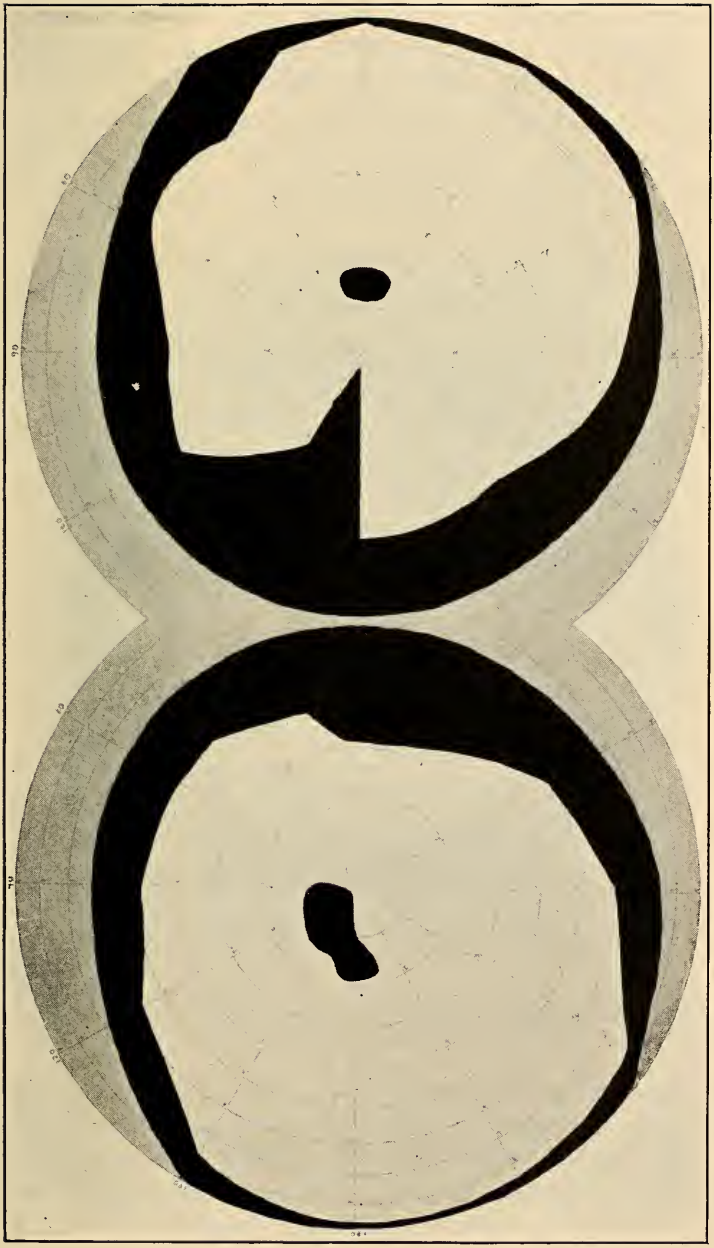

Fig. 15.—Diagrammatic charting of the field of vision, indicating extension of the blind area in the glaucomatous eye.

the hand may be brought in to the center or further before it is seen. In Figure 17 only a small area of the visual field remains. The patient's sight is constricted and the world appears to him as though he were looking through a rifle barrel. And yet he can read print, one or two letters at a time, if they are placed directly in the right position.

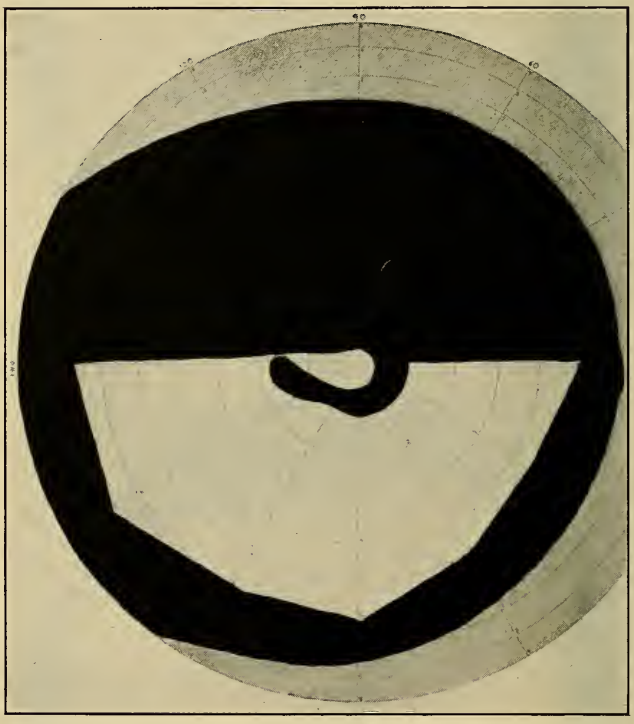

Fig. 16.—Diagrammatic charting of the field of vision of a glaucomatous eye in a still more advanced stage, showing darkened area of blindness encroaching further in the field of vision.

There are minor signs of glaucoma also which the patient may notice. Temporary haziness of vision, the seeing of rainbow rings around lights at night, difficulty in reading, the necessity of a very rapid increase in the strength of one's glasses. But glaucoma can exist without one's noticing such

signs and it is therefore advisable after middle life to have a periodic examination of the eyes made by an expert.

Glaucoma if untreated leads to blindness. Glaucoma recognized late is exceedingly difficult to control. Glaucoma recognized early lends itself much more favorably to treatment. What is the treatment of glaucoma? Some method which will

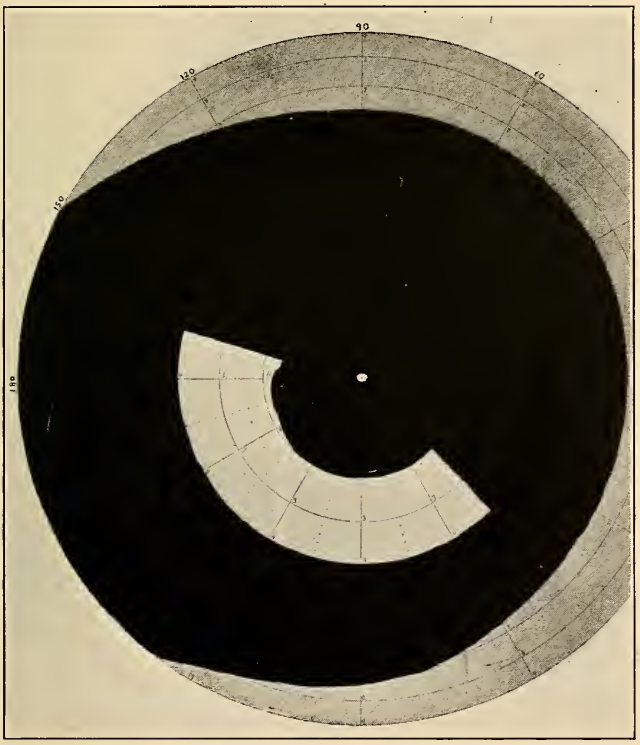

Fig. 17.—Diagrammatic charting of the field of vision of a glaucomatous eye, showing only a small area of the visual field remaining.

bring back to a normal level the increased pressure in the eye. This naturally cannot be accomplished by glasses. There are certain drugs known which contract the pupil and lower the pressure in the eye. In certain cases, carefully selected by the expert, these drugs may be used to control the disease and drops

are therefore put in the eyes regularly four or five times a day. In spite of using these drops the disease is likely to progress slowly and after a time the drops lose their effect. Therefore, in most cases the proper treatment of glaucoma is an operation skilfully performed. We have shown in Figure 5 how the drainage area of the eye becomes partially blocked. Once

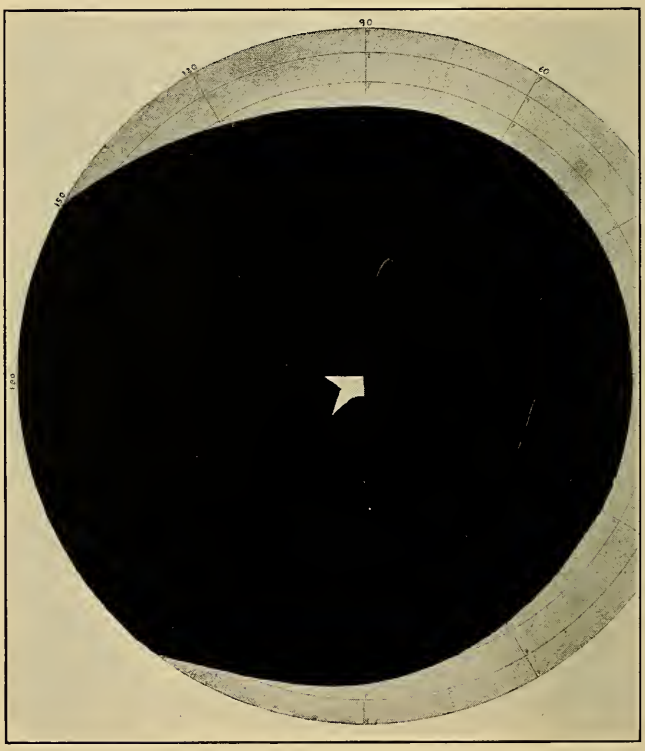

Fig. 18.—Advanced glaucoma. Only center area of vision left.

blocked in this way it can never be restored. But it is usually possible to make a new drainage pipe which will keep the pressure of the eye permanently low. Such operations are now being performed throughout the world by the hundreds and show a very large percentage of success. Let us remember

one other thing. Chronic simple glaucoma almost always sooner or later affects both eyes.

How are you, yourself, going to recognize early this disease and retain your eyesight? By periodic examinations of the eyes after the age of forty-five. If your eyes blur in reading or you see rainbows around lights, get expert advice. If your sight becomes reduced so that glasses do not restore it, get expert advice and be sure that your adviser is medically trained. Optometrists who also fit glasses are not medically trained and do not treat diseases of the eye. They refer you to a physician who has specialized in disease of the eye. And when you have received expert medical advice, TAKE IT!


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